PROJECT ASSIGNMENT BPA36
in the Bachelor´s Program EIT

Topic: Electron Lithography-Based Technology Development of III-V Devices

Task:

The terahertz band, which lies in the frequency range between 0.1 and 10 THz, is a part of the electromagnetic spectrum. This radiation is utilized in various fields, such as spectroscopy, aerospace engineering, and communication. A significant area is wireless communication. Terahertz radiation offers a high bandwidth and data rate, and the development of 6G is already underway. The limiting factor for this is the high absorption of the terahertz band in the atmosphere, which can be attributed to the water vapor content, as well as the challenge of producing devices with high power in this frequency range. Research into high-power sources for this spectral region has yielded various components that can meet these requirements. These include optical sources such as p-Germanium lasers or quantum cascade lasers, as well as electronic devices like heterojunction bipolar transistors (HBT), complementary metal-oxide-semiconductor transistors, resonant tunneling diodes, and high electron mobility transistors (HEMT). In the range of 1 THz, there is a kind of gap for high-power sources compared to surrounding areas. Here, HBTs and HEMTs offer a promising solution.

A key feature of HEMTs is their high electron mobility, which can reach up to 2700 cm^2/Vs at room temperature. This mobility is provided by a two-dimensional electron gas that forms at the interface. Additionally, HBTs based on InP can be utilized for these applications due to their very high intrinsic electron mobility of up to 4600 cm^2/Vs. The high electron mobility also leads to a high saturation velocity of the electrons in the material. Since the high speeds of the electrons enable the potential for a high operating frequency, it is promising to build terahertz sources from these devices. To achieve the required frequencies, the components are miniaturized, which shortens the transit time of the electrons at the same saturation velocity, resulting in higher frequencies. The sizes of the structures for such small devices range from 50 nm to several hundred nm, which leads to the choice of electron beam lithography as the method for structure transfer.